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Boron: An Important element for Agricultural Productivity

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ABSTRACT: *Boron is unique, not only in its chemical properties, but also in its roles in biology. Boron is an essential micronutrient and its availability in soil and irrigation water is an important determinant of crop productivity. Boron deficiency in Indian soil is the most common and widespread micronutrient deficiency problem, which inhibits plant growth and reduces yield. Plant requires an optimum dose of B for healthy growth and development. Deficiency symptoms start with the youngest growing tissues because it is not translocated from old to new tissue. Therefore, optimum B supply is essential for obtaining high yields and good quality of agriculture crops.*

Keywords: Boron, Agricultural Productivity

INTRODUCTION

Boron is an element that has properties which are Borderline between metal and non metals. Atomic number-5, Atomic wt.-10.811, Electron configuration of outer shells- 2, 3, Common oxidation states- +3.

B is one of the eight essential micronutrient, required in small quantities (0.01-1000 ppm) and generally less than 1 ppm they are also called trace elements. Minute quantities of B produce optimum effects but a slight deficiency or excess of B is harmful to the plant. B is the only nonmetal among the plant micronutrient.

TOTAL BORON IN SOIL

The total boron content of most agricultural soil ranges from 7 to 630 mg kg^{-1} with an available content of lower to 12.2 mg kg^{-1}. In India, range of boron in major soil orders inceptisol and allfisol is 8 to 18 mg kg^{-1}. Such wide variation among soils in the total boron content is mainly ascribed to the parent rock types and soil types falling under divergent geographical and climatic Zones. Boron is generally high in soils derived from marine sediments. Indian soils are deficient in boron- 33%.

STATUS OF BORON DEFICENCIES IN INDIAN SOILS

	Average deficiency	Soil orders	States with extent of deficiency
Boron	35%	Alfisols, Entisols, Inceptisols, Ultisols	Bihar 39%, West Bengal 68%, Orissa 69%, Assam 17%, East UP 24%, Karnataka 32%.

SOURCES IN SOIL

The most common boron containing mineral is tourmaline which contains 10% boron. Kernite, ulexite, kotoite, axinite and colemanite, these minerals are main sources of boron in soil.

REQUIREMENT OF BORON IN PLANTS

- The boron content in plants ranges from 32 to 100 mg kg^{-1}.
- B content is high in dicot plants than monocot plants.
- Leaves of legume crops 32 to 95 mg kg^{-1} boron.

- Lowest- 15 to 25 mg kg^{-1}
- Optimum- 25 to 100 mg kg^{-1}
- Higher- more than 200 mg kg^{-1}

FORMS

In soil solution, boron mainly exists as un-dissociated acid H_3BO_3. The most common geologic forms of boron is boric acid [also written as B $(OH)_3$] and H_2BO_3 are the most common geologic forms of boron and boric acid is the predominant form in soil. Boric acid is the major form of boron in soils with H_2BO_3 being predominant only above pH 9.2. Boron occurs in aqueous solution as boric acid B $(OH)_3$, which is a weak monobasic acid that acts as an electron acceptor or as a Lewis acid.

Boron available in plants are different forms as Tetraboret (B_4O_7), Arthoboret (H_2BO_3), Diboret (HBO_3) and Triboret (BO_3). Only 5% part present in these forms of total boron.

BORON REQUIREMENT OF SOME CROPS

High	Medium	Low
Alfalfa	Asparagus	Barley
Apple	Carrot	Beans
Broccoli	Corn	Blueberry
Cabbage	Cotton	Cereals
Cauliflower	Cherry	Citrus
Celery	Onion	Com
Clovers	Peach	Cucumber
Mustard	Pear	Grasses
Peanuts	Potato	Oat
Rape	Radish	Peas
Red Beet	Spinach	Pepper
Sugar Beet	Tobacco	Rye
Sunflower	Tomato	Sorghum
Turnip	Parsnip	Wheat

FUNCTIONS OF BORON IN PLANTS

1. Boron plays an essential role in germination of pollen grains and growth of pollen tubes.
2. Boron plays an essential role for seed and cell wall formation as well as in the development and growth of new cells.
3. Boron forms sugar/borate complexes associated with sugar translocation.
4. Help in absorption of nitrogen.
5. Boron is an important element in protein synthesis as well as in absorption of salt in plant.
7. It regulates carbohydrate metabolism.

DEFICIENCY SYMPTOMES OF BORON

- B deficiency symptoms appear on new leaves of plants.
- Yellowish or chlorosis which starts from base to tip.
- Tip becomes very much elongated into a whip like Structure and becomes brownish or blackish brown.
- Leaves become thick and margin upwardly rolled.
- Hollow stem of cauliflower, browning of cauliflower curd, top sickness of tobacco and hard fruit of citrus, heart rot of beat, internal cork of apple, yellow tip of alfalfa etc.
- Decreases of flowers and fruit of plants.
- Symptoms on terminal buds.
- Alfalfa (*Medicago sativa* L.) shows red and yellow colour development on young leaves due to boron deficiency.

TOXICITY OF BORON

- Chlorosis of tips of older leaves especially along the margins.
- The edges of older leaves of Alfalfa burnt due to B toxicity.
- Boron toxicity in barley is characterized by elongated, dark- brown blotches at the tips of older leaves. Severe browning, spotting, and burning of older leaf tips occur.
- Tip and marginal burning of corn's leave and yellowing between the veins due to B toxicity.
- Pea-Boron toxicity results in suppression of plant height and in the no. of nodes.
- Boron toxicity suppresses plant height and number of nodes in pea.
- Due to boron toxicity in potato, there is arching mid-rib and downward cupping of leaves and necrosis at leaf margins of nodes.

BORON COMPOUND COMMONLY USED AS FERTILIZERS:-

B Source	Chemical Formula	Solubility in water	% B
Borax	$Na_2B_4O_7.10H_2O$	Soluble	11.3
Fertilizer borate	$Na_2BO_7.5H_2O$	Soluble	14.3-14.9
Anhydrous borax	$Na_2B_4O_7$	Soluble	21.5
Solubor	$Na_2B_8O_{13}.4H_2O$	Very soluble	20.5
Boric acid	H_3BO_3	Soluble	17.5
Colemanite	$CaB_6O_{11}.5H_2O$	Slightly soluble	15.8
Ulexite	$NaCaB_5O_9.8H_2O$	Slightly soluble	13.3
Boron frits	Boric oxide glass	Very slightly Soluble	2.0-11.0

CONCLUSION

Boron chemistry in soil is depending on various soil components and ions and in plants the mode of operation of boron differs considerably from that of other micronutrients. Boron plays a significant role in plant nutrition and in environment. It is obvious that an extreme deficient or toxic level of boron may be responsible for secondary effects on account of the reduction in plant growth and resulting in a change of physiology and biochemistry of plants. There is a small range for boron between deficiency and toxicity in soil, plant and water systems.

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